

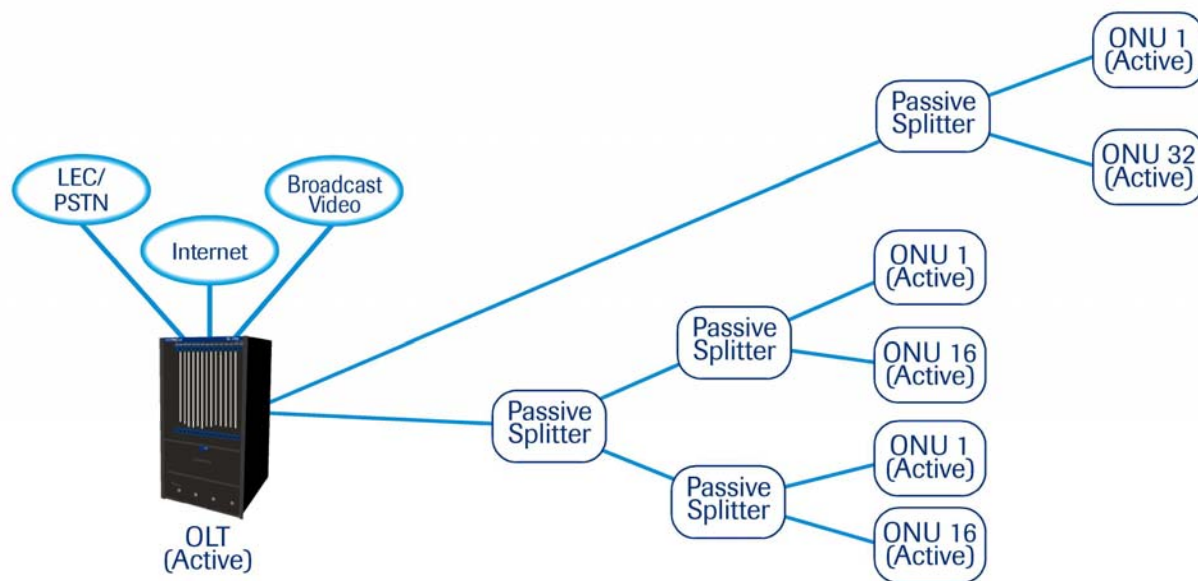
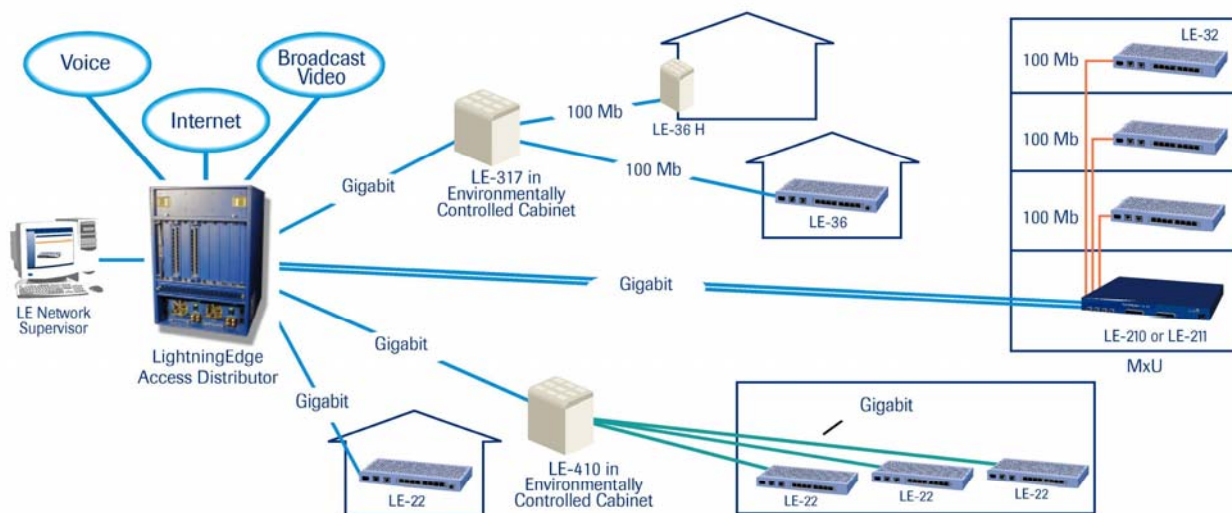
World Wide Packets®
ACCESS BRILLIANCE

Exploring Active vs. Passive Optical Networks

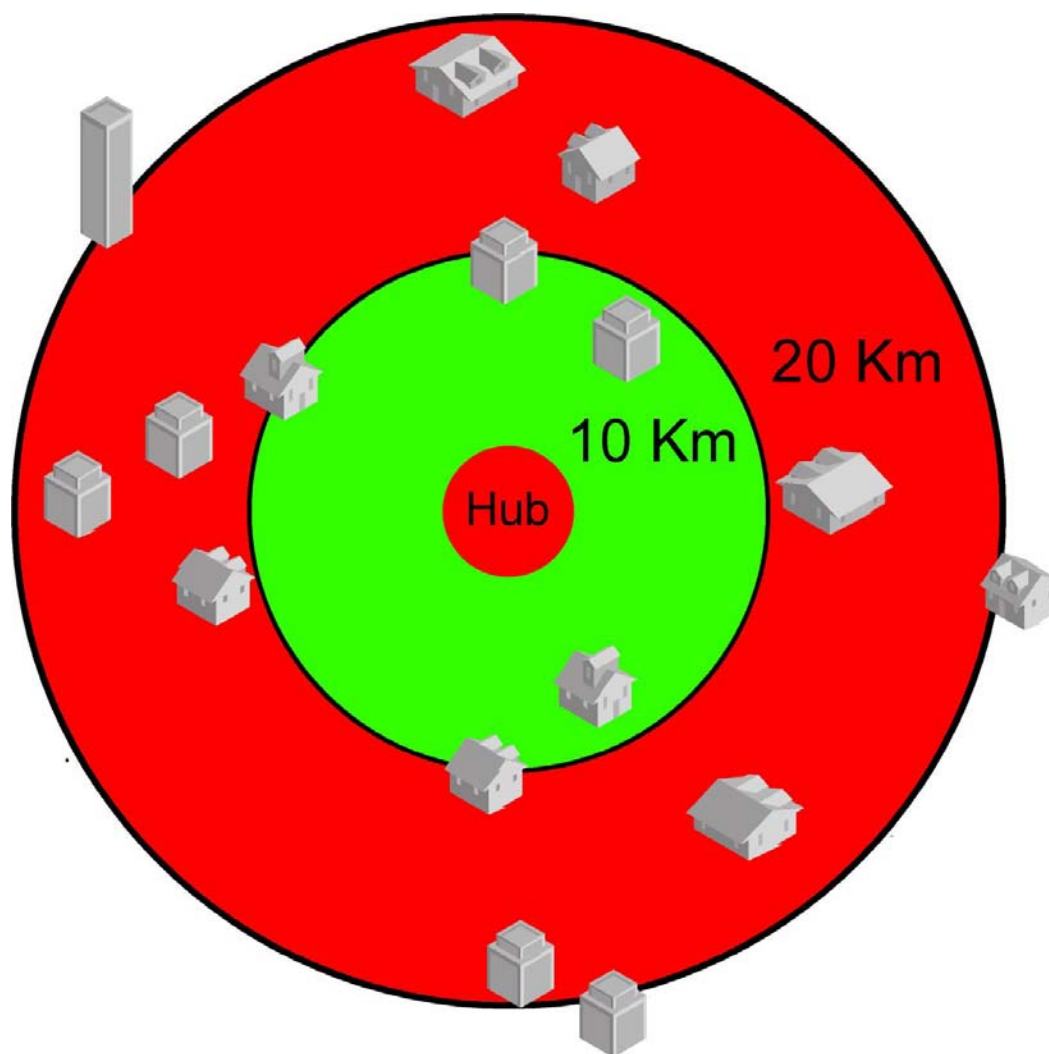
September 29, 2004

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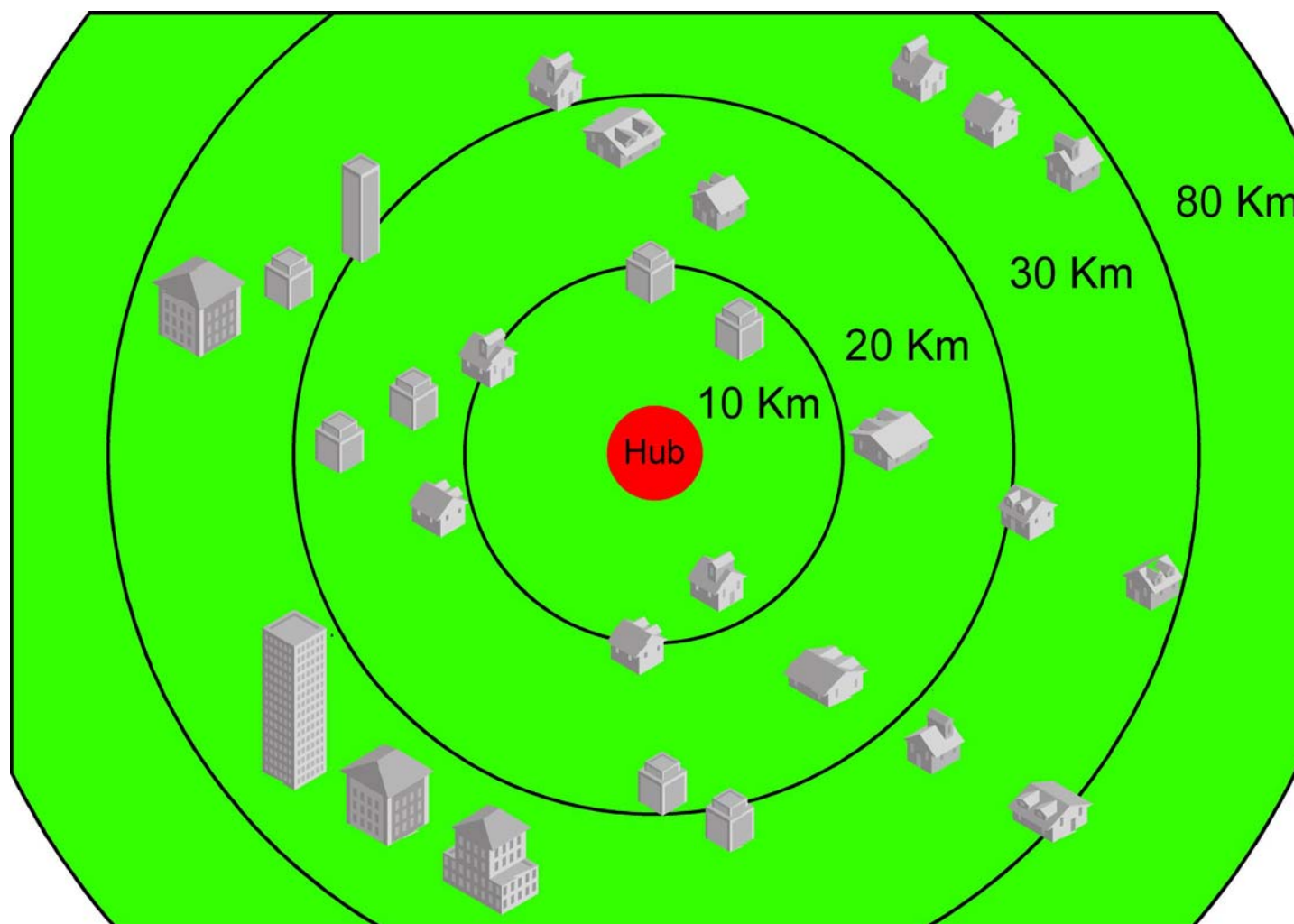
Definitions



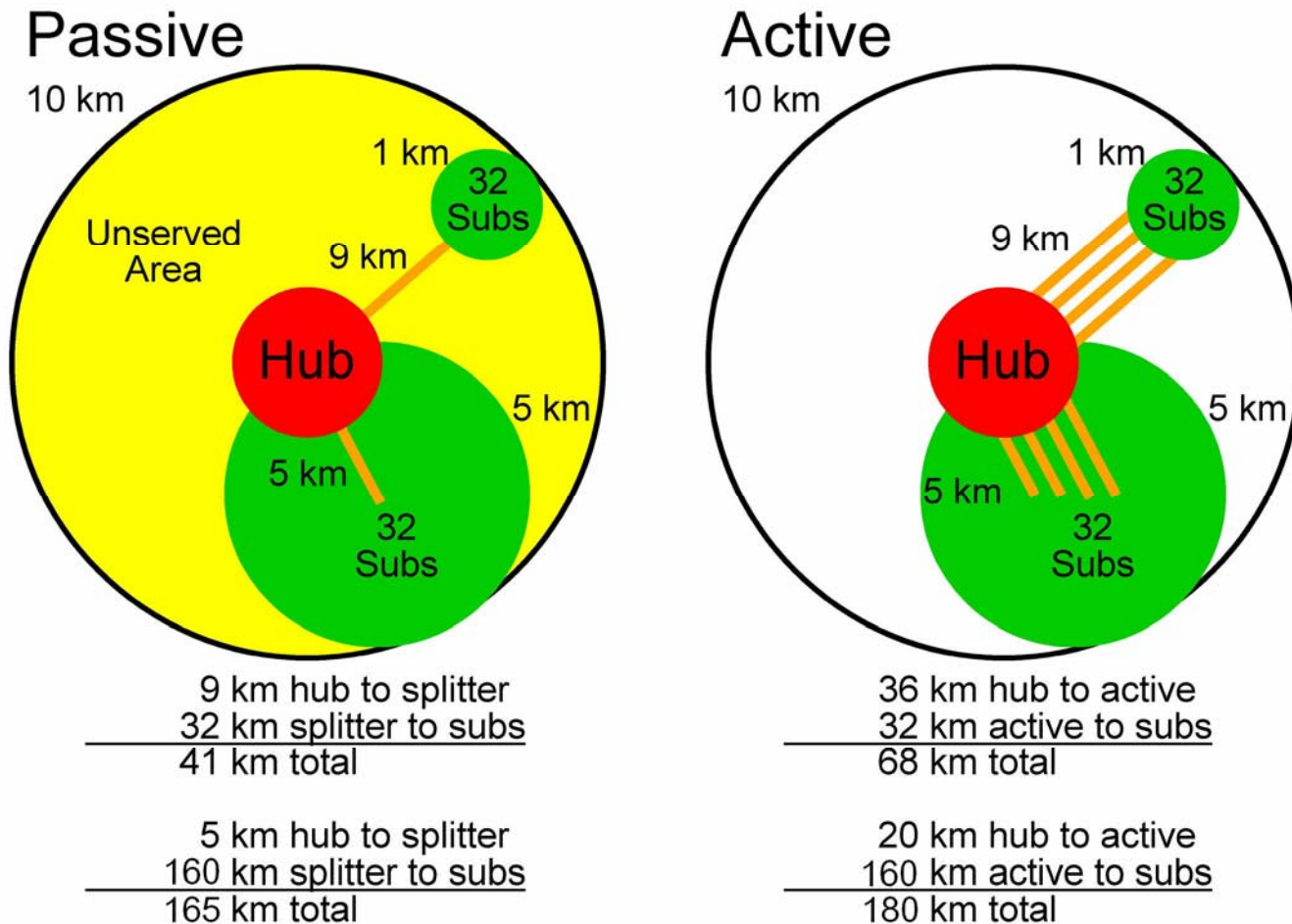
Passive Reach



Active Reach



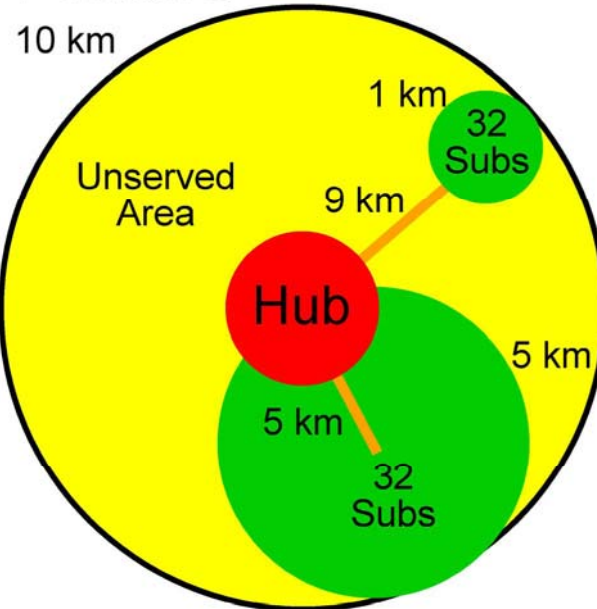
Fiber Deployment Differences



Same labor cost, but 100 Mb/s (active) vs. 31.25 Mb/s (passive)

Deployment Cost Differences

Passive

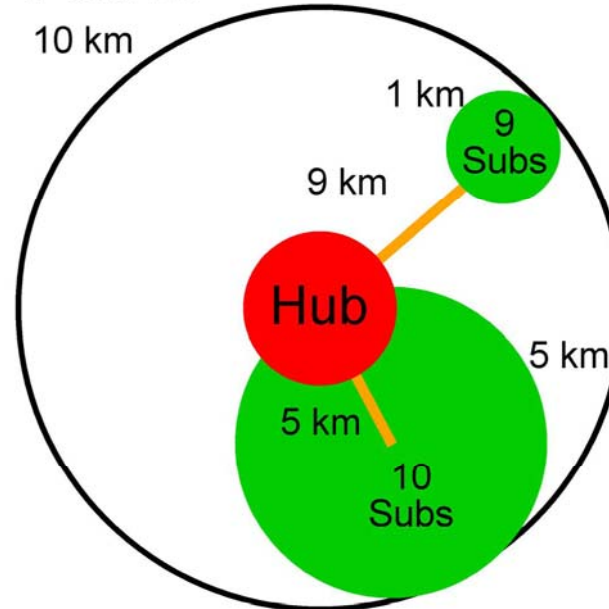


Deployed for 64 subscribers
Take rate = 30% or 19 subscribers

70% of capital expenditure not
producing revenue return

New subscribers outside green
areas require additional capital

Active

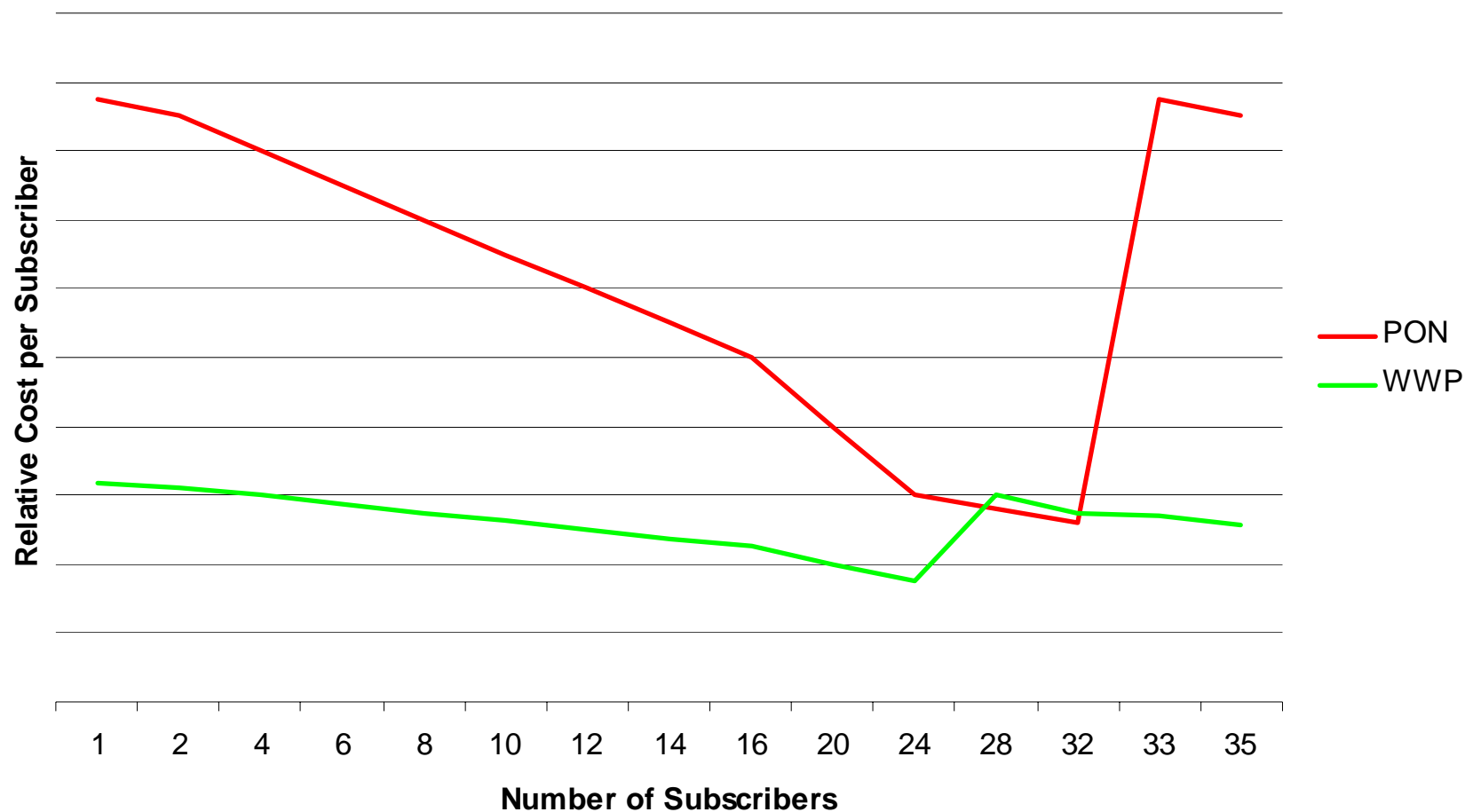


Deployed only as subscribers
are added

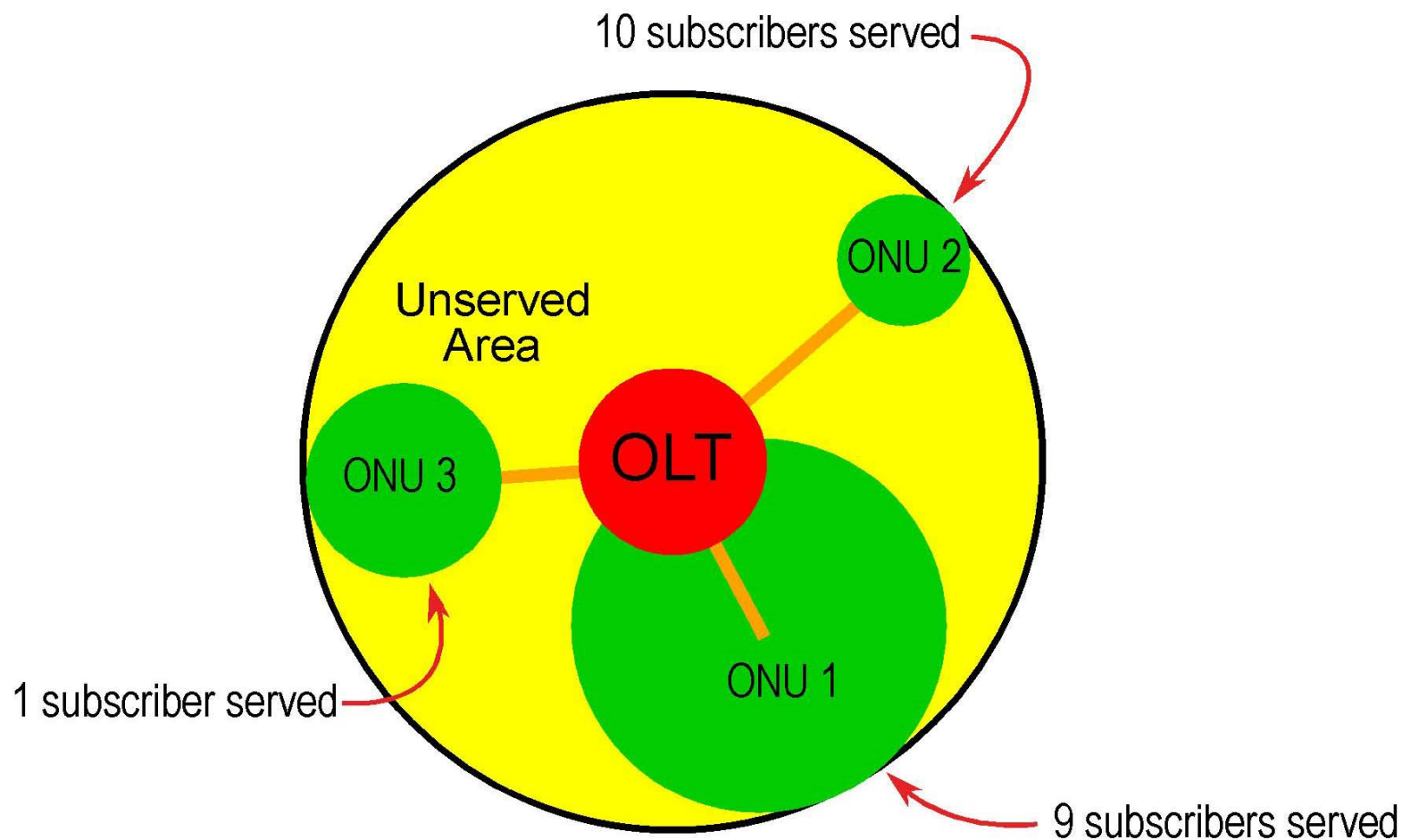
All capital producing revenue
return

New subscribers can be added
up to 80 km from hub

Relative Cost per Subscriber



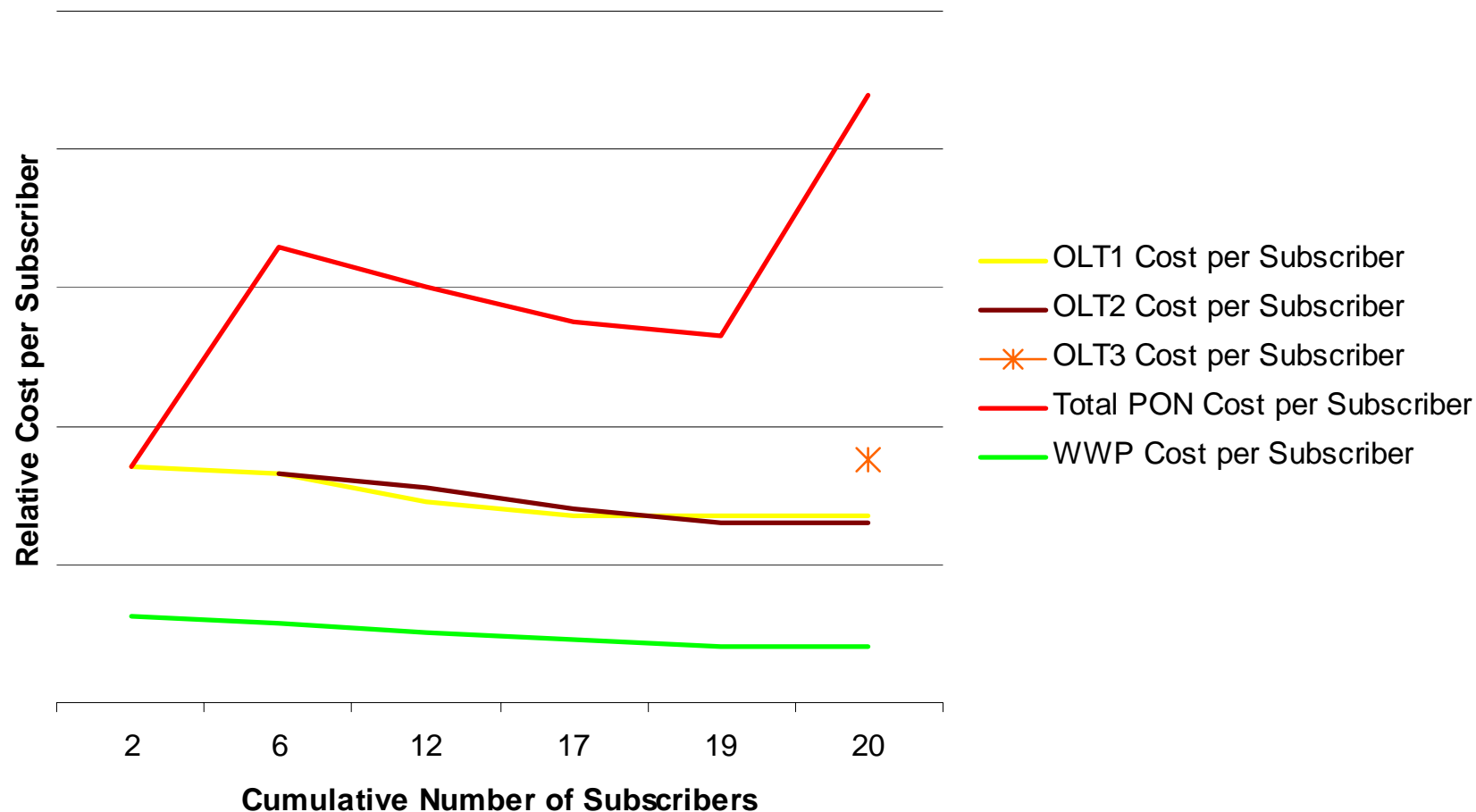
Deployment Scenario



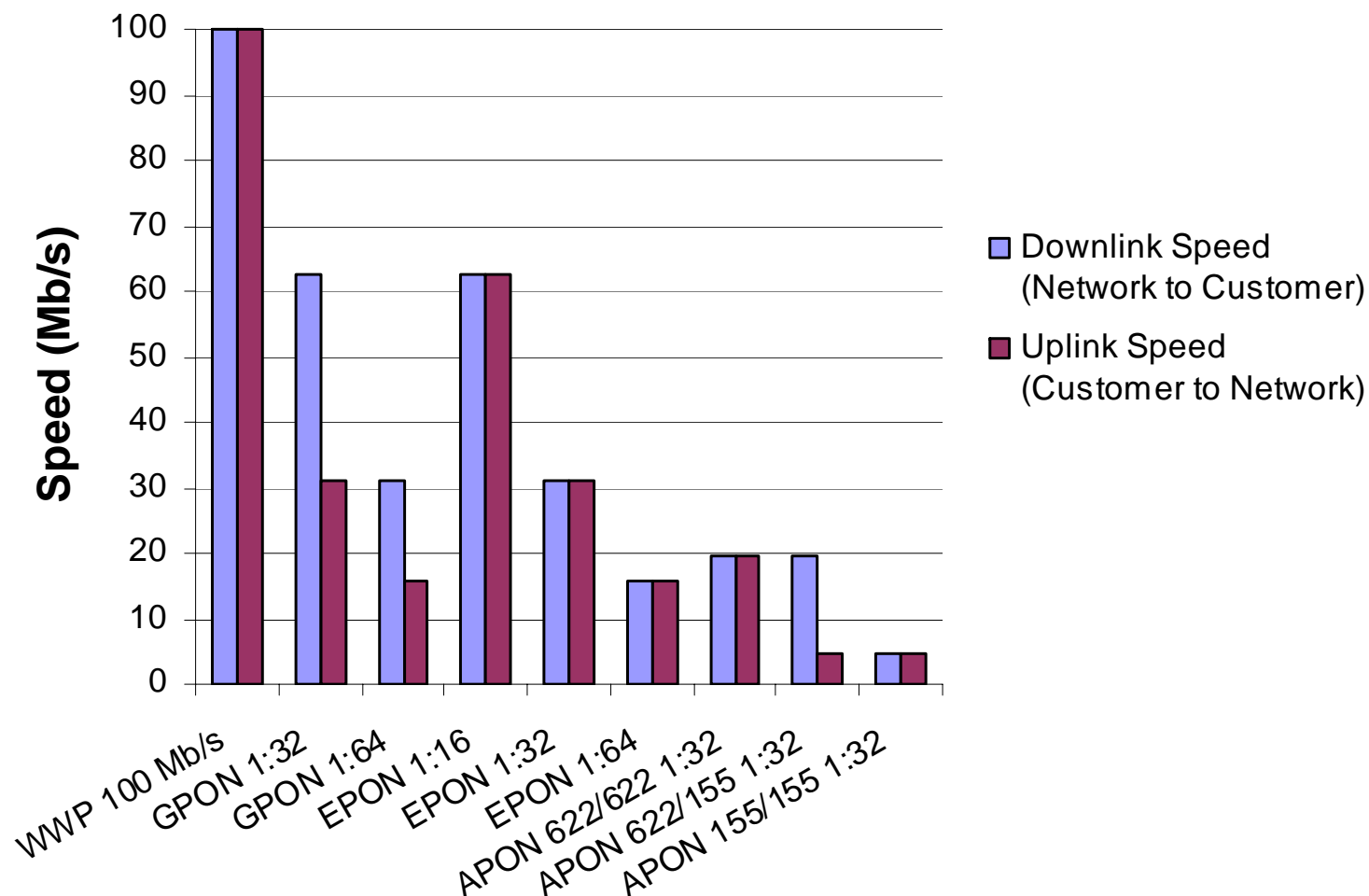
Fill Ratio Comparison

PON	ONU1	ONU2	ONU3	Cumulative Subscribers	Supported Subscribers	OLT Fill Ratio	Stranded OLT Investment
Time Period 1	2			2	32	6.3%	93.8%
Time Period 2	1	3		6	64	9.4%	90.6%
Time Period 3	4	2		12	64	18.8%	81.3%
Time Period 4	2	3		17	64	26.6%	73.4%
Time Period 5		2		19	64	29.7%	70.3%
Time Period 6			1	20	96	20.8%	79.2%
WWP				Cumulative Subscribers	Supported Subscribers	Concentrator Fill Ratio	Stranded Concentrator Investment
Time Period 1				2	24	8.3%	91.7%
Time Period 2				6	24	25.0%	75.0%
Time Period 3				12	24	50.0%	50.0%
Time Period 4				17	24	70.8%	29.2%
Time Period 5				19	24	79.2%	20.8%
Time Period 6				20	24	83.3%	16.7%

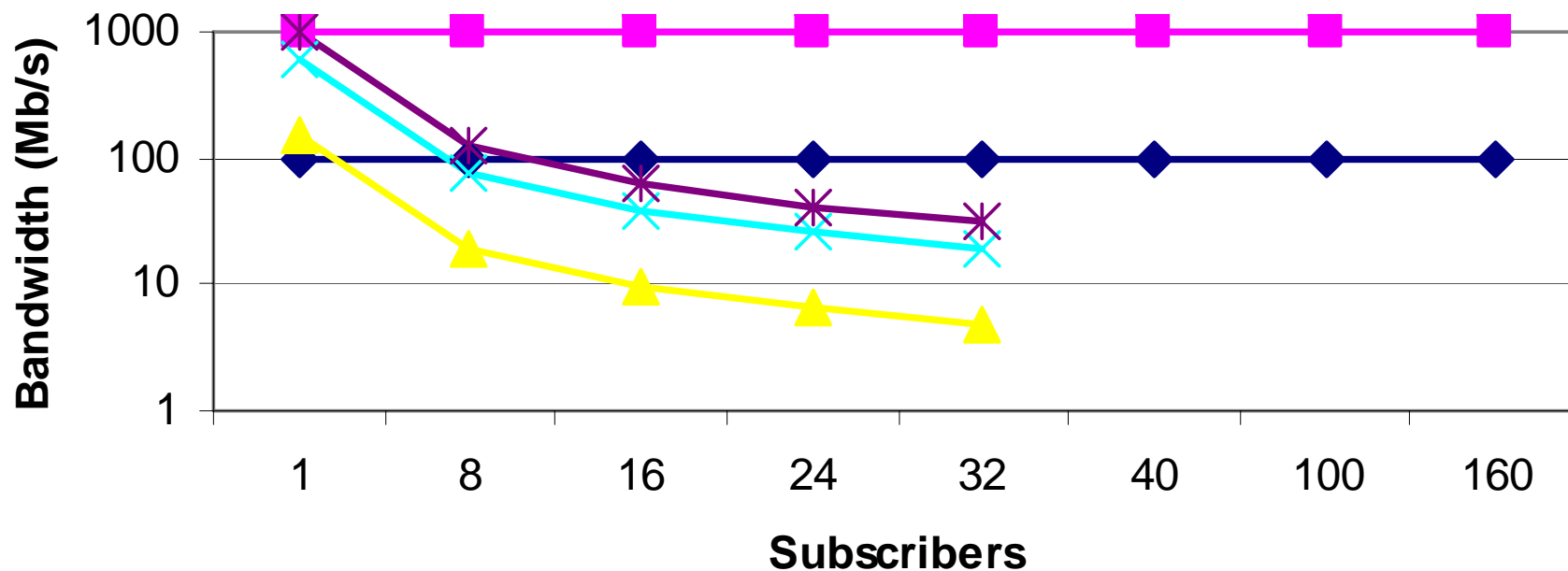
Cumulative Cost per Subscriber



Bandwidth per Subscriber



Bandwidth per Subscriber (cont.)



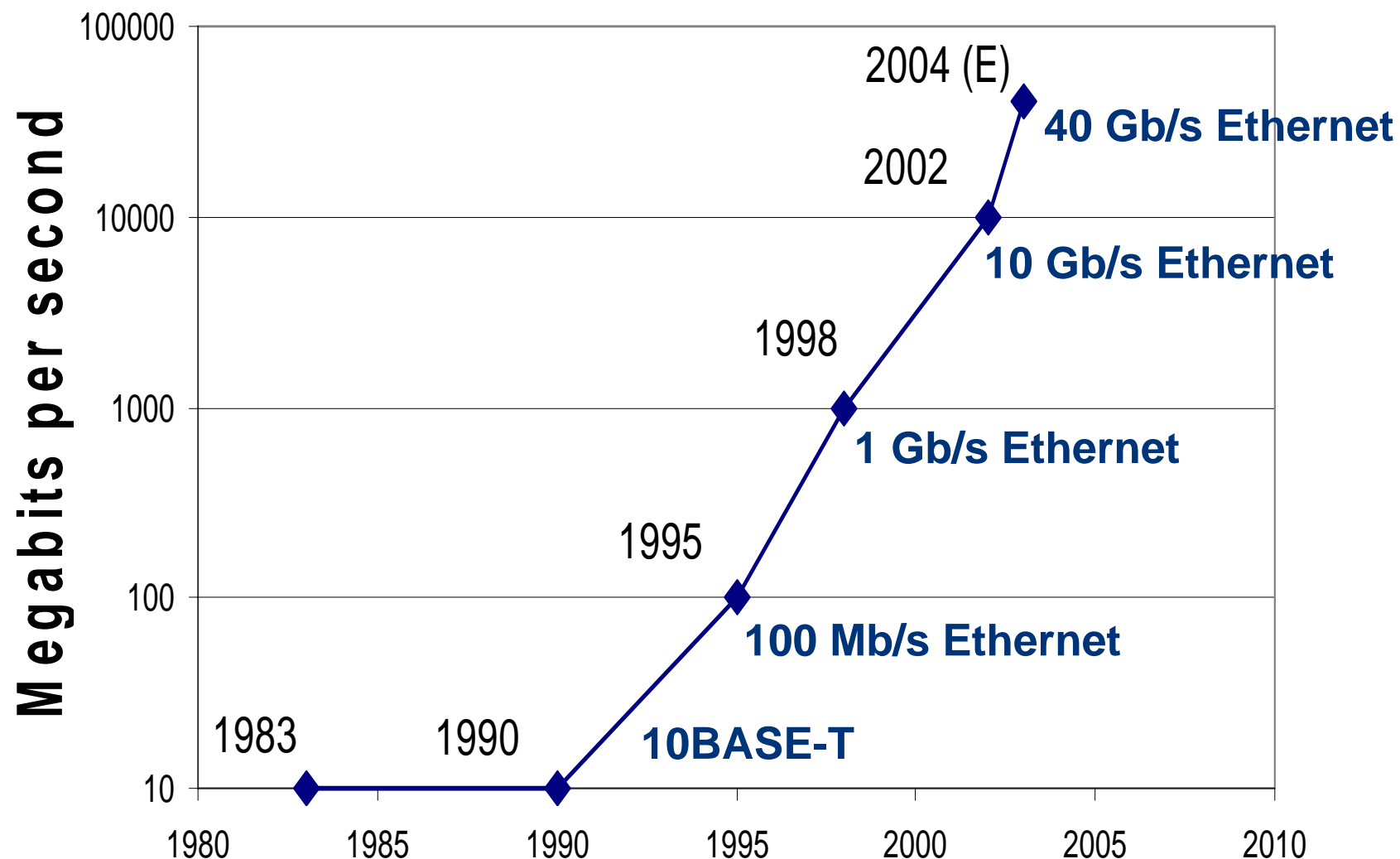
- Active 100 Mb/s
- Active 1000 Mb/s
- Passive APON 155
- Passive APON 622
- Passive EPON 1000 Mb/s

Revenue Potential

	64 kb/s	3 Mb/s	6 Mb/s	30 Mb/s	100 Mb/s
Active Business Subscriber	Voice \$100 - \$1,000	Data \$100 - \$1,000			Additional Services \$100 - \$1,000
Active Residential Subscriber	Voice \$30	Data \$40	Video \$40	VoD \$10	Additional Services \$40 - \$100
Passive Subscriber	Voice \$30	Data \$40	Video \$40	VoD \$10	
Cable Subscriber	Voice \$30	Data \$40	Video \$40		
DSL Subscriber	Voice \$30	Data \$40			
PSTN Subscriber	Voice \$30 Data \$20				

- Additional services include videoconferencing, telemedicine, HDTV, video phones, interactive digital video, distance learning, security, energy management, appliance control, etc.

Ethernet Scalability



Network Flexibility

■ **Active**

- **Moves, adds, and changes can be done without interruption to existing services or subscribers**
- **Supports multiple topologies without geographic or distance restrictions**
- **Capital investment coincides with revenue generation**

■ **Passive**

- **Recommended to deploy all splitters before a single subscriber is added to avoid service disruption**
- **To increase bandwidth, must re-do fiber runs to reduce number of subscribers per splitter, must replace electronics**

Content Delivery Flexibility

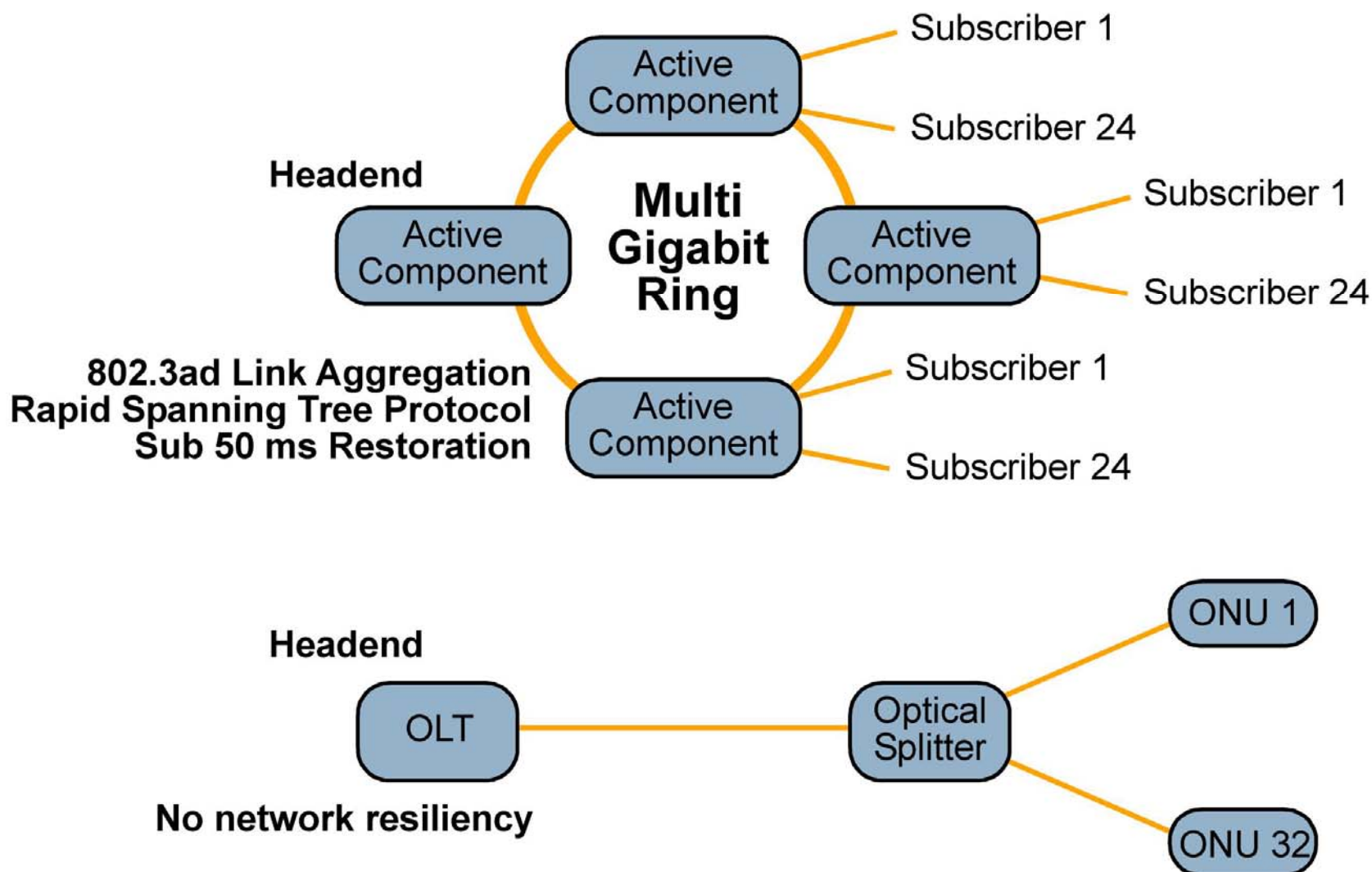
■ **Active**

- Fully supports one or many content providers per subscriber
- Supports usage based accounting per port, per service, and per subscriber
- Content sent to one subscriber does not impact bandwidth, or revenue potential, of other subscribers

■ **Passive**

- Not well suited to separate traffic between content providers
- Content delivered to subscribers on the same splitter consumes shared bandwidth even if only one subscriber is being serviced with it

Network Reliability



Actives in the Field

Number of Subscribers	Number of Distribution Sites	Number of Concentration Sites (96 subs/site)	Number of Concentration Sites (864 subs/site)	Number of Portal Sites	Total Sites (96 subs model)	Concentration Sites as % of Total Sites	Total Sites (864 subs model)	Concentration Sites as % of Total Sites
1,000	1	11	2	1,000	1,012	1.09%	1,003	0.20%
2,500	1	27	3	2,500	2,528	1.07%	2,504	0.12%
5,000	1	53	6	5,000	5,054	1.05%	5,007	0.12%
10,000	1	105	12	10,000	10,106	1.04%	10,013	0.12%
25,000	1	261	29	25,000	25,262	1.03%	25,030	0.12%
50,000	1	521	58	50,000	50,522	1.03%	50,059	0.12%
100,000	1	1042	116	100,000	101,043	1.03%	100,117	0.12%

Standards

■ **Active Ethernet**

- **Fully compliant with all Ethernet 802.3 standards**
- **Widespread deployment reduces cost of components and solution**
- **Seamless upgrade path to 10 Gigabit Ethernet (802.3ae)**
- **Full interoperability between large number of vendors**

■ **Passive**

- **APON standards in place, but ATM significantly increases cost of deployment and limits bandwidth**
- **EPON standards still in early development, many proprietary formats competing to become standard – network interfaces not interoperable with 802.3 Ethernet devices**
- **GPON standards recently completed**
- **Limited, if any, true vendor interoperability**

Advantage – Active Ethernet

- **Broadens market potential**
 - Allows more, and greater variety of simultaneous services
 - Greater set of choices increases take-rate
 - Increased take-rate increases revenue
- **Enables addition of new services as opposed to substituting existing revenue services with new services**
 - Ultra-broadband service capable – e.g. HDTV and business video
- **Drives customer loyalty**
 - More selection and choice is a strong deterrent to customer churn

Fiber Technologies of Interest

- **CWDM – Extremely helpful in maximizing the use of existing fiber**
- **Bi-Directional optics – Extremely helpful in maximizing the use of existing fiber**
- **DDI data from optics – Helps network operators to diagnose fiber problems from the NOC and helps to reduce cost**

21 ■ **In general any technology that can help**

Thank You